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Deepthi P V

Department of Chemistry, Nehru Arts and Science College, Kannur University, Kanhangad - 671314, Kerala, India.

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Deepthi P. V.
Department of Chemistry, Nehru Arts and Science College,
Kannur University, Kanhangad - 671314, Kerala, India.
deepthi@nasc.ac.in

ABSTRACT: Global consumption of cosmetics has increased due to unrealistic beauty standards, which has caused a corresponding increase in the manufacturing of cosmetics. This causes a spike in the use of heavy metals added to cosmetics. The heavy metals lead, mercury, arsenic, cadmium, cobalt, and nickel, are commonly utilized in the production of cosmetics and personal hygiene products. The detrimental consequences of heavy metals differ based on a number of variables, including exposure duration and dose. The primary concerns in a wide range of issues include carcinogenicity, neurotoxicity, nephrotoxicity, lung damage, dermatitis, cardiovascular disorders, renal dysfunction, and endocrine, developmental, and reproductive disorders. These shed light on the harmful consequences on the ecosystem's diverse flora and fauna. This review aims to investigate the impacts of heavy metals on the environment, the harm they can do to human health, and the significance of mitigating these effects. Heavy metal poisoning events can be avoided by enforcing stricter norms, prohibiting dangerous compounds, and ensuring compliance with regulations.

KEYWORDS: Cosmetics, Heavy Metals, Health Risk, Toxicity.

1. Introduction

Cosmetics have been a part of human culture for thousands of years and perform two primary functions to maintain personal hygiene and improve beauty [1]. These products used to be created locally with natural ingredients. Nevertheless, over time, industrialization has evolved the cosmetics field to become increasingly wider and more globalized thanks to social media and advertising. This change introduced the move away from natural to synthetic petrochemical-derived formulations. This was due to the desire for more stability, longer shelf life, and increased aesthetics [2]. During the last two decades, a steady growth in demand was observed for eco-friendly and natural cosmetic formulations. Thousands of cosmetics can be accessed today; these include nail polish, perfumes, foundation and highlighter (blush), and security practices such as sunscreen moisturizers [3,4]. These products enhance appearance and offer people the confidence and possibility to be who they truly are. The effect of cosmetics also goes beyond daily life and plays a role in entertainment. The increasing realization of improving one's physical appearance has led to a global surge in demand for cosmetics in recent years. It's interesting to note that this market, cosmetics, and personal hygiene have not been significantly impacted by the state of the economy [5,6].

The use of cosmetics, particularly skin-lightening products, is prevalent in African, Latin American, Asian, and Gulf countries. Initially, it was believed that makeup was limited to its surface and could not pierce the epidermis [7[. Subsequent research, however, revealed that substances might enter the body through the skin and raise questions about safety. Several hydrophilic and hydrophobic organic and inorganic compounds are used in cosmetic goods. Mineral pigments and heavy metals such as cobalt (Co), nickel (Ni), arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg) are used in coloured cosmetics [8]. Therefore, manufacturing cosmetics in large amounts with a variety of components raises serious health and safety problems. To differentiate cosmetics from topical medications, regulatory authorities tried to define them. A cosmetic is defined in the European Union (EU) by Council Directive 93/35/EEC, which modifies Council Directive 76/768/EEC [9,10]. This definition is helpful in that it enumerates the exterior body parts that cosmetics can cure and implies that all other body regions should not be included in cosmetic treatment analytics. Additionally, it distinguishes between cosmetics and human-use medicinal products, which are governed by the

Medicines Act and include soap, and determines that pseudo-pharmaceuticals can only be supplied by pharmacists [11].

Cosmetics are not subjected to the same comprehensive testing as topical medications before being put on the market. The security of cosmetics is the responsibility of producers, importers, and distributors. Regulations specify and include certain heavy metals in a long list of compounds that are not allowed to be used in cosmetics [6]. Some substances are completely prohibited (tin and its salts, arsenic, and cadmium), while many others are only allowed in certain amounts or in certain salts (cobalt, chromium, gold, mercury, etc.). Natural sources may inadvertently contain these metals. Various natural makeup elements, such as honey, argan oil, olive oil, and citrus essential oils, have been shown to contain certain heavy metals, such as cadmium (Cd), lead (Pb), nickel (Ni), and arsenic (As) [6,12]. Consequently, regulatory agencies have set restrictions on the amounts of certain metals in cosmetics to alleviate these concerns. For instance, the US Food and Drug Administration's Cosmetic Ingredient Review (CIR) Expert Panel sets non-binding limitations of 5 ppm arsenic, 5 ppm lead, and other heavy metals (20 ppm). The World Health Organization has set Pb (10 ppm), Cd (0.3 ppm), and Hg (1 ppm). While Canadian authorities have imposed limits on Pb (10 ppm), Cd (3 ppm), and Hg (3 ppm), EU authorities have set limits of 0.5 mg/kg for Pb, Cd, and Cr. Although different regulatory organizations have different metal restrictions, disparities in authority are likely to confuse manufacturers and regulators, necessitating consumers [13,14]. Research has identified instances of heavy metal contamination in specific cosmetic products and the associated risks to human health and nearby ecosystems. If concentrations of these hazardous metals rise over predetermined limits, the environment and public health will suffer greatly. The FDA, Bureau of Indian Standards (BIS), and EU restrict the use of heavy metals in cosmetics to assist in lower exposure. Research indicates that even with these laws in place, the levels of hazardous metals present in cosmetic items frequently exceed the allowable limits. Hazardous waste from the heavy metal-based cosmetics industry is deposited in landfills, waterways, and air streams. These are non-biodegradable pollutants that cling to soil and water, lowering their quality [15-17].

Some heavy metals found in cosmetics are dense and very dangerous when they leak into the environment, whereas others are more likely to be unstable. These hazardous metals harm both human and other organisms' health when they enter the food chain. Lead, mercury, and cadmium are all found in large quantities in the environment, particularly when plants absorb them from the soil [16]. Animals may eat or drink polluted food or water, and the metals they store within their bodies are then carried over through the food chain. Lead, mercury, and cadmium are hazardous metals that do not contribute much to metabolism and are always harmful, even at low exposure levels. While some metabolic processes depend on key minerals like copper, chromium, iron, manganese, and zinc. Numerous health difficulties, including neurological illnesses, renal damage, developmental defects, heart problems, infertility or hormone problems, mood swings, skin impacts, and hair loss, can be caused by these toxic metals. As respiratory poisons, heavy metals can mess with hormones [17]. Although there is a considerable danger, there is still a lack of information and evidence regarding its toxicity. Environmentally friendly goods like eco-friendly cosmetics lessen the harm that heavy metals due to the environment. Green chemistry is the foundation of green cosmetics, which maximize organic natural content while reducing waste production [18-20]. As a result, despite its potential, manufacturers do not widely embrace green cosmetics due to their expensive cost and lengthy manufacturing process. This review focuses on the heavy metal content in cosmetics and their impact on human health and the environment.

2. Heavy Metals

Heavy metals are metallic elements that can form salts, mostly found in the periodic table's d and p blocks. They frequently have a high atomic number, high weight, or density (high mass per unit volume). Heavy metals include lead, arsenic, cadmium, and nickel are typical examples. These metals are found in many living and non-living components and are mostly produced by a variety of industrial processes, mining and smelting activities, burning fossil fuels, and traffic pollution from moving vehicles [21,22]. This growth of metals in the environment is largely driven by consumers, which virtually guarantees that they will continue to pose a health risk to humans. In biological processes,

heavy metals can resemble necessary elements and obstruct physiological function. This disruption is not limited to humans and mammals but also affects other animals, such as insects, and plants. The frequent or daily use of makeup items such as eye shadows, lipsticks, and face powders can lead to the buildup of heavy metals in biological systems. Animals other than humans and mammals are also impacted by this disruption, including plants and insects [22-24].

Due to their high levels of acute oral toxicity, several heavy metals are toxic agents. They wind up in the air, on land, or in water when industry spits them out into our environment. These metals are absorbed by plants, which then allow them to go up the food chain and accumulate in other creatures. Heavy metal exposure is linked to major health issues such as cancer, organ failure, harm to neurological functioning, and developmental illnesses, making it a significant public health concern [25]. Cosmetic heavy metals can be absorbed from the skin surface and may cause either local effect on the skin or systemic intoxication. They can build up in the skin, especially in stratum corneum which may result in local responses e.g., allergic contact dermatitis, particularly with metals like nickel, cobalt, and chromium. Furthermore, these metals are capable of penetrating further into the skin and thus can be absorbed systematically by deposition in other organs. This may be caused by free radical formation and inflammation, which causes damage to the skin. Long-term exposure could also potentially harm health from some carcinogenic metals [26,27].

2.1 Lead

One of the well-known heavy metals, lead, is often regarded as a hazardous contaminant that has a significant negative influence on human health. Lead is a neurotoxin that can damage important organs in the reproductive system [28]. It is both hepatotoxic and nephrotoxic. Because lead can impact fatal development by passing via the placenta, prenatal exposure to lead is particularly concerning. Moreover, certain research has suggested that lead may be a likely human carcinogen [29-32]. According to studies, people who use lead-containing eye cosmetics have blood levels that are three times greater than those of non-users. Lead can be found in the environment in a variety of places, including automobile emissions, outdated paint toxins, burning fossil fuels that may taint food, and industrial dust and fumes [33-35].

The World Health Organization has set a limit of 10 parts per million for the allowable content of lead in cosmetics, with many regulatory bodies across the globe having set higher or lower limits [36]. Furthermore, the FDA has established a stricter limit of 20 ppm when such an additive is used primarily as a colour, and a maximum permitted level of 10 ppm for lead-in colour additives applied to items intended for cosmetic production. Studies on lead, particularly in lipstick cosmetics, have shown inconsistent findings. Some studies have discovered quite significant levels of lead in lipsticks, particularly for some close to the legal limit, while others have found little to no lead at all. Lead content in eyeshadows has not been widely documented. Regarding face products, such as powders and foundations, some companies said that the product included anything from 190 ppm to nothing at all. However, with high amounts in some products, nearly 25% of popular anti-aging creams and 10% of face washes surpassed FDA standards [36-39]. Similar to the aforementioned eye goods, various cosmetics such as hair dyes, body creams, skin-lightening hand creams, and mouth toothpaste have been found to consistently contain significant concentrations of this neurotoxic metal when used topically. The aforementioned chart illustrates the prevalence of lead contamination in numerous cosmetic formulas at measurable levels, including those for which safe limits have been established by regulations [21-23].

2.2 Mercury

Mercury is a naturally occurring element that takes various organic and inorganic forms, the most relevant of which usually results from anthropogenic (coal extraction) or natural activities like erosion — volcanic eruptions [40]. It can enter the human body through different pathways such as absorption of skin, inhalation and swallowing or eyes contact. Thereby extended use of mercury-containing cosmetic products gets absorbed through the skin and remains in the body, entering into blood circulation. This may lead to various health hazards including neurotoxicity, nephrotoxicity, and

digestive problems which can be life-threatening. Mercury is used as a preservative, bleaching agent, and skin brightener in the cosmetic industry [41-43].

Although harmful, mercury is cheap to incorporate into cosmetics and it acts very rapidly. Due to deficient regulatory control, mercury persists in use within the industry — a problem for human health and environmental protection alike. Mercury can be used in skin-bleaching creams, and it prevents melanin formation by inhibiting the enzyme tyrosinase. Other types of cosmetic products, such as face creams sunblock, and hair products are reported to contain only low levels of mercury in some cases while skin-lightening creams, beauty glamours, or even toothpaste have been found so high yet. Some inorganic mercury, such as mercuric chloride is used for disinfectants, lipsticks, and eye shadows [44,45]. Mercury poisoning may result in systemic illness with symptoms such as vomiting, nausea, and renal failure. It can have central nervous system effects as well, including irritability muscle tremors, slowing of developing brain and mental degeneration (forgetfulness), fatigue, weakness, and anxiety. Furthermore, mercury can lead to sensory impairment which will reduce hearing capacity or cause loss of taste and vision. At its worst, mercury toxicity can be deadly [46-49]. Once mercury is absorbed through the skin and into the body can induce autoimmune glomerulonephritis. Studies have shown that mercury can greatly concentrate in the different organs and body fluids. Mercury in hair can get up to 22.5 ppm for example twice the level of mercury than non-cosmetic users [50]. As a result, the blood mercury values of some women could be raised to 233 nmol/l (compared with the maximum level among non-cosmetic users) and urine levels increased up to 2531 nmol/day while no higher than fifty times in maintained products for this exposure group [48-49,51].

The FDA forbids the use of mercury in the production of cosmetics and permits lead acetate-containing mercury to be added to cosmetics at maximum concentrations of 1 ppm. Although the production of cosmetics is prohibited in the European Union, phenyl mercuric salts may be utilized as preservatives in eye care products at a maximum concentration of 70 ppm. Phenyl mercuric salts may be used up to 65 parts per million in the US by weight [52,53]. A maximum of 1 part per million (ppm) of mercury may be present in cosmetics manufactured by Health Canada. Studies on skin-lightening creams have mostly focused on this topic because of melanin metabolism. Mercury levels below the 3-ppm limit have not been documented in several investigations, and they may even be as high as 126000 ppm in certain skin whitening creams [54]. Mercury levels as high as 80 parts per million have also been discovered in lipstick products, despite some investigations finding mercury levels below the detection threshold. There seems to be a wide range of mercury contamination in eye cosmetics. In eye shadows and related goods, mercury concentrations can rise to 181 parts per million. While other cosmetics like mascara may have mercury levels as low as 0.002 ppm, eyebrow pencils may have levels as high as 67.42 ppm [13,14,54-56]. Mercury levels in body care eye foundations have been reported to reach 60.77 parts per million (ppm), although face creams, sunscreen, and face paint have meager amounts of 0.09 to 0.004 parts per million. While some hair products have mercury levels below the detection limit, others have levels as high as 90.32 parts per million. Depending on the kind of body product, different amounts of mercury were discovered in body care products [57-59].

2.3 Cadmium

Cadmium is mostly used in cosmetics as a colorant for its yellow (dark-hued) and orange salts [2]. Despite having a low percutaneous absorption level of 0.5%, cadmium can nevertheless produce skin irritation [60]. One significant issue is that it may wind up in our tissues as a result of its function and then gradually enter the bloodstream. linked to nephrotoxicity, diabetes mellitus, lung cancer, and osteoporosis [61]. Additionally, promotes tissue distribution that primarily affects the skeletal system (bones up to 95%), and reproductive system, including damage to gamete cells (membrane) during development, hypertension (suffixed at the cellular level via extensive activation of the angiotensin-regulated pathway), metabolic disorders (10% diabetes), which results in loss of insulin classes, and renal disease. Oxidative stress, which can cause skin aging, is another health issue associated with cadmium [62].

Instead of being deliberately incorporated into a product, cadmium is typically found in cosmetics by cross-contamination. Cadmium is a poisonous chemical that can be found in some modern-day industrial waste or the environment. Most nations have set limits on the amount of cadmium allowed in

food, and the World Health Organization (WHO) determined that 0.3 ppm is the most quantity that may be tolerated [63, 64]. While Health Canada restricts concentration at 3 ppm, based mostly on acute oral toxicity evidence with questionable reliability and applicability to skin contact exposure [50], the European Union has outlawed the use of cadmium and its salts in all cosmetic goods. Research reveals that cosmetics' cadmium concentration varies greatly. This amount is frequently less than 5 ppm in lipsticks, but it can reach as high as 60.20 ppm in others [63-65]. While some research observed higher levels of up to 55.59 ppm, most studies revealed that eye shadows are greater than the LOD, with mean levels less than 3 ppm [65]. Various publications have reported varying levels of cadmium in face cosmetics, such as creams and foundations. One investigation [61] established thresholds of up to 17 parts per million for Cd in makeup foundation. Without providing any further advantages, cadmium is mostly employed as a pigment agent in cosmetic applications outside of the United States. However, cadmium exposure in any amount can lead to several health issues, including kidney failure, lung cancer, heart disease, and aging skin types. High cadmium levels, which can also be found in certain products like Kohl, cause keratitis, a serious eye condition, and elevations cause a greater risk [11].

2.4 Arsenic

Specifically, arsenic is a strong metalloid abundant in the earth's crust and a seriously harmful environmental pollutant. Despite being redox inactive (arsenate anion), arsenic replaces sulfhydryl groups on proteins by binding directly to cellular thiols and eventually lowering glutathione levels, the body's defence against oxidative stress [66]. This makes cells more vulnerable to damage from heavy metals and radicals. While prolonged contact with the skin might result in keratosis and hyperpigmentation, systemic absorptions can induce vascular disorders and cancer [66,67]. Regulators have established criteria for the presence of arsenic even though it is one of the least significant heavy metals as a cosmetic contaminant because of the dangers associated with prolonged use [52]. The highest permissible level of arsenic in lead acetate used as a colorant is 3 parts per million, as determined by Health Canada and the FDA [5,50,69]. The EU outlawed the use of arsenic and its derivatives in any kind of cosmetic product [65].

Majority of cosmetics have minimal levels of arsenic, never going above the 3-ppm threshold specified for food; larger levels have been discovered in a few specific products [54,70]. For instance, lipsticks typically have an arsenic concentration of up to 0.34 ppm (although one study suggested it might be as high as 6.931 ppm) [52]. With a few exceptions, these levels fall under the permissible range for arsenic concentration (mostly found in makeup used on the eyes, such as mascara, eyebrow pencils, and eyeshadows). A study reported that the eye cosmetic, arsenic was found to fall into a dangerous ppm range, ranging from 810 to 1630 ppm (parts per million) [52,54,70]. Generally, less than 1 ppm, face foundations, and creams have a little higher arsenic content than other face products [71,72]. Additionally, a lower category of face paint was discovered to contain arsenic, with maximum levels found to be 25 ppm [73]. Arsenic in hair care products, including colours, conditioners, and shampoos also has minimal levels of Arsenic in skin-lightening/body lotions (less than 3 ppm). It was found in several instances higher concentrations in toothpaste up to 26.94 ppm of arsenic has also been found in toothpaste at times [66,67]. However, arsenic is rarely found in significant quantities in cosmetics; however, its presence, especially in illegal or underground market products, raises concerns about potential health risks. The use of arsenic in cosmetics is ongoing because it results very rapidly, however, the consequences for health are severe with skin disorders, hair loss, and also potential types of cancer including bladder and lung as well as diabetes and cardiovascular diseases [74].

2.5 Nickel

Naturally occurring substances that are frequently utilized in cosmetic products may include the metal contaminant nickel. Although nickel's green-coloured salts imply that it may be employed as a colorant, nickel is also a well-known contact allergen that, when exposed to over time, can result in allergies of the systemic (asthma) and cutaneous (allergic contact dermatitis) types. Jewellery and cosmetics contain nickel. Exposure to nickel may result in respiratory issues such as lung and nasal cancer in addition to skin reactions [10,75]. Nickel may produce oxidative stress, which causes the skin to age through overexpression of collagenases rather than collagenases [60,76]. Nickel is occasionally added to

cosmetics to improve skin health and prevent it from weakening with age. During this process, our skin's structural integrity is compromised, leading to a loss of suppleness. The International Agency for Research on Cancer (IARC) has categorized metallic nickel as possibly carcinogenic to humans (Group 2B), with a small number of its constituents being agents that cause cancer (Group 1) [77-79]. Although nickel can naturally reside in soil and volcanic dust, industrial processes can release nickel into the environment.

Nickel is controlled to prevent exposure as it might trigger allergic reactions in the skin. Controlling the amount of nickel (Ni) in products is necessary since it can cause skin sensitivity. Maximum concentration limits apply to even household items such as 5 ppm for solvents and other chemical feedstocks and less than or equal to 1 ppm for specific detergents [80,81]. Cosmetics with nickel content that are labelled as "nickel-free" are include nickel lower than 1 ppm [82,83]. The limit set for oral consumption is 0.20 ppm [84]. The European Union, which has the largest cosmetics market in the world, has outlawed the use of nickel and a number of its derivatives in cosmetic goods. These compounds include nickel sulphate, dinickel trioxide, and nickel monoxide. However, studies show that there is a wide range of nickel content in different cosmetic items [65]. It has been discovered that cosmetics like lipstick and lip products contain 0.10–22.8 ppm nickel. There has been recorded variation in toothpaste nickel levels, ranging from 0.02 to 18.535 ppm [85]. Eye makeup, including mascaras and eye shadows, frequently has concentrations higher than 1 ppm, with values as high as 359.4 ppm documented [15,86,87].

Significant amounts of nickel are also included in body creams and makeup foundations [88]. Exposure to cosmetic nickel may then exacerbate long-term allergy reactions, but it is not frequently enough to account for disorders like dermatitis of the eyelids [89]. Chronic exposure to nickel in cosmetics can also lead to neurological issues, cardiovascular disorders, fibrotic lung alterations, and renal failure. Because nickel can disrupt fetal development and result in genetic harm, it is concerning that metal can pass through the placental barrier. Controlling the use of nickel in industrial processes and correctly managing trash containing nickel is crucial due to the possible dangers involved. To avoid negative effects on human health, consumer goods like cosmetics must adhere to strict regulatory guidelines regarding the amount of nickel they contain [5,15,69,85].

2.6 Cobalt

Cobalt is used in many industrial sectors including jewellery, paint pigments, and prosthetics materials to increase the corrosion/wear resistance of allow and magnets. When combined with other oxides and then heated, cobalt oxide can create blue-green and yellow colours in ceramics, glass, paints, or body art [90-92]. Cobalt salts are used as antioxidants, colour pigments (used in makeup and hair dye), also external drying agents used for oil-based paints; alkyd resins printing ink varnishes; lacquers enamels as oleate linoleate naphthenate Cobalt compounds, cobalt sulphate, and other soluble cobalt (II) salts are all rated Group 2B by the IAR. Cobalt is a common skin allergen associated with allergic contact dermatitis. European patch test data of over 25,000 individuals demonstrated an average sensitization rate to be approximately 7.9% [91-95].

In the 1970s and 1980s cobalt in consumer-purchased items was identified as a significant cause of allergy [96,97]. Chromate (which may co-exist with nickel allergies in some cases) and cobalt can form an allergen from exposure to either individual substance [91]. Cobalt has limited data available on human skin penetration. However, cobalt ions can migrate through the skin in vitro using the Franz cell method; and this capacity depends on the sweat's ability to oxidize a metallic form of cobalt. Also, it was revealed that cobalt particles penetrated injured skin more easily than intact skin. In contrast, levels of urinary cobalt were higher in volunteers with skin exposure to Cosmetics. Studies on animals have suggested that slow excretion of cobalt in the urine, and prolonged skin retention after dermal application with soluble salts may elicit cutaneous immune responses [5,97,98]. Cases of cobalt allergy induced by cosmetic products have been published. Cobalt (in a face massage lotion to be used for iontophoresis) was responsible for the severe hand dermatitis that occurred in an unsuspecting therapist's hands. In another example, a woman with her nails done with cobalt-containing gels developed pruritic and eczematous lesions on the hands [71,97,98]. Cobalt and its salts are prohibited from being used directly in cosmetic goods by EU legislation. However, no specific cap on cobalt

impurity levels was set. Dose-response studies ranging from 1 μg/g to 50 μg/g have identified threshold concentrations in cobalt-allergic patients [10, 97,98].

The majority of the goods that were evaluated (such as body creams, nail paints, and lipsticks) had low or undetectable quantities of cobalt. The products with the highest levels were henna colours, hair treatments, face paints, and eye shadows [99]. For instance, cobalt levels in Chinese eye shadows were found to be between 100 and 250 μg/g, and this has been linked to eyelids in the past. An analysis of eighty-eight eye shadows from respectable cosmetics brands revealed that more than ten times the concentration of cobalt per gram was found in as many as twenty colours, with the most intense tints, including dark grey-black, being the most prevalent [100-105]. In comparison to European samples, the majority of Asian cosmetics had noticeably greater cobalt contents. The cobalt levels in the European eye shadows were as high as 2.42 μg/g, while the Japanese face powders ranged from 3.21 to 5.64 μg/g[106,107]. Additionally, the cobalt contents in certain products vary from place to place, for which common limits need to be administered. Children's coloured face paints and toy makeup kits are common sources of cobalt at concentrations of more than 10 μg/g[107-109]. Hair creams sold in certain places have high cobalt levels of 10–25 μg/g, which puts users at risk for health issues because hair cream is used frequently and there are no regulations to reduce exposure to humans. According to reports, henna dyes contain 0-3,9 μg/g of cobalt [34,110,111].

3. Impact of heavy metals

Heavy metals and the human body have complex interactions. Heavy metals can enter the human body through three main routes: oral ingestion, inhalation, and skin absorption [112]. Cosmetics like eyeshadow, nail polish, body lotions, and lotions can cause skin sensitivities and open up heavy metal pathways when applied topically. Recent studies have shown that heavy metal-based nanoparticles are added to cosmetics to increase their effects and efficacy in dental, hair, and skin care applications. Nanoparticles can enter the skin through hair follicles and keratinocytes**.** When heavy metal-containing cosmetics are used consistently, the metals will build up in the body and eventually find their way into the general circulation through the layers of the skin. Skin, organ, and possibly cancer damage will result from this [113, 114, 115]. Then, heavy metals will enter the mouth through the use of lip balms, lipsticks, and other dental care products. Studies show that heavy metal levels were greater in the blood and urine of cosmetic consumers than in non-users [34, 116]. As hydrating compounds present in cosmetics induce skin pores to open, heavy metals can enter the general circulation through them. These metals can bind to a variety of biological molecules and take the place of other helpful substances. This disruption of DNA and RNA production can result in carcinogenesis

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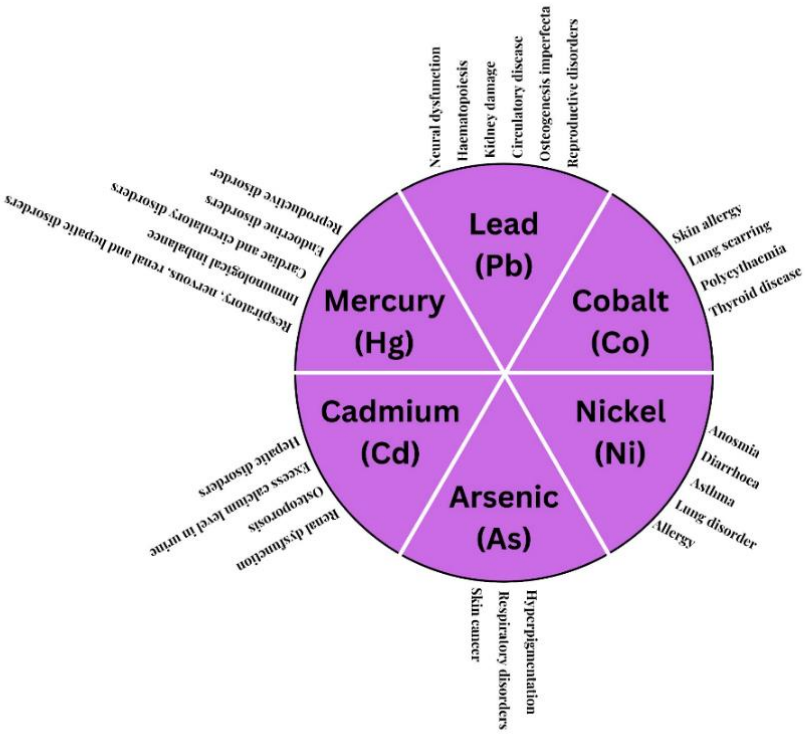

Figure 1: Heavy metal-related health issues in humans

The Environment is a combination of humans, plants, animals, and other microorganisms and these all are dependent on the land, water, and atmosphere for their life [117,118]. As All the species and resources are linked to each other, any damage or pollution in land, water, or air will affect the whole environment. Environmental pollution from heavy metals is a serious threat due to its negative impact all over the globe. Due to the increased growth of industries and agriculture and their improper methods of waste disposal to landfills, water resources, and the atmosphere, heavy metal content in the environment will gradually increase [119]. The cosmetic industry is also a part of heavy metal waste distribution to the environment [120]. These industries use numerous chemicals and metals for the manufacturing of their products for profit and speeding up their process and this will result in huge amounts of inorganic waste materials, which are then discarded without any proper treatment [121].

3.1 Soil pollution

The UNEP states that "the most hazardous heavy metals are among the various materials that make up the components of cosmetics and their opulent packaging materials." Recycling or reuse is not possible. Inadequate collection and treatment will undoubtedly result in landfill waste, which will cause major harm to the ecosystem [117,118,122]. Along with their growth, cosmetic businesses are discarding an increasing amount of trash every day. Among the many materials found in these wastes are various heavy metals. Although it is well recognized that heavy metals are exceedingly toxic to both living and non-living species, these wastes are routinely disposed of in the soil without any regulations or safety precautions [118]. In industrial areas, soil is one of the most important sites for waste disposal. The microorganisms cannot biodegrade the metals contained in that waste and chemical deposition in the soil increases [123]. These metals will remain in the soil at very high concentrations for a long period, resulting in a higher level of toxicity. Also, they deactivate the biodegradation of organic compounds in soil, resulting in infertility. In heavy metal-polluted soil, several growth defects, low yields, and reduced life spans can be seen in living organisms [118]. Through the food chain, plants can carry out their absorption, through which the metals reach plants and bring them into contact with human beings as

well as other living organisms, which leads to ecological imbalance and bio-accumulation [124]. Through phytoremediation, plants help reduce the heavy metal content in soil. However, as the toxic content of the soil increases with the increase in waste disposal, it is not possible to do this every time. At any cost, soil contamination through anthropogenic activities cannot be encouraged [125]. Contamination of the soil can impact all forms of biodiversity effect of heavy metal on the environment has been shown in figure 2. Strict rules and regulations for the disposal of waste that contains these metals must be implemented by the government environmental protection agencies [126,127].

3.2 Water pollution

The introduction of pollutants like heavy metals into water bodies is a major environmental and social issue because of their harmful impact on aquatic life and humans [128]. Heavy metal content in water, sediment, and fish will affect the food chain. Fish are more likely to get heavy metal poisoning as they are sensitive to heavy metal pollution. This will have health consequences for fish and affect their reproduction, immune system, and pathological diseases [129]. Waste water released from cosmetic industries and disposal of cosmetic products containing heavy metals after use into water bodies like lakes, rivers, and oceans is one of the main channels for heavy metal pollution in water. As we know, these metals can't be decomposable by microorganisms and they can stay in the water for a long time. This rise in heavy metal content in water bodies will completely affect the aquatic ecosystem [130-132]. To remove heavy metals from wastewater, environmental researchers have introduced numismatic methods such as photocatalytic reduction, membrane filtration, ion exchange methods, electrolytic processes, etc. More than these methods, people have to raise awareness about waste disposal in water bodies and its consequences [133-135].

3.3 Air pollution

Atmospheric contamination is considered as a global concern because of its effects in humans and other living organisms. Long-term exposure to air pollution will lead to asthma, lung cancer, bronchitis, hypertension, cardiopulmonary disease, and several respiratory disorders. Studies based on air pollution consequences found that millions of premature deaths are recorded annually due to air pollution [136]. Elements like lead, mercury, and cadmium are classified as group one carcinogens, and inhalation of these metals directly will be crucial for vital organs and tissues [137]. Cosmetic factories and the burning of cosmetics waste will release several toxic gases into the atmosphere, which contain a bunch of chemicals, including these metals. They are then absorbed by the particulate matters present in the atmosphere which will leads to soil and water deposition [138]. The excess air pollution will also result in ozone depletion and global warming. The tremendous increase in industrialization will result in giving out toxic gases to the atmosphere uncontrollably which makes our planet not fit for living [139].

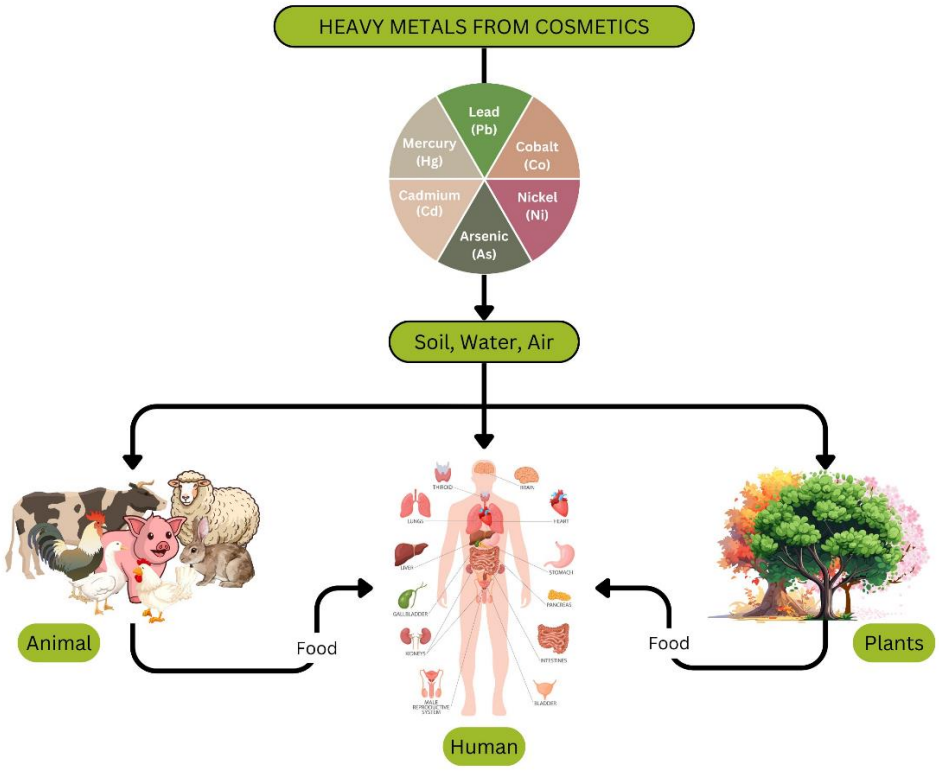

Figure 2: Environmental hazards from heavy metals

4. Cosmetic regulations and cosmetic acts

Each product is made for different purposes and is made in different forms. Some of them contain a variety of chemicals and other synthetic substances. In India, cosmetics regulations are coming under, the Drugs and Cosmetics Act of 1940 and the Rules of 1945 [140,141]. As per the Drugs and Cosmetics Act, "cosmetics" is described as an article used for cleansing, altering appearance, and enhancing appearance, whether applied by rubbing, spraying, sprinkling, pouring or any other method, including items designed as cosmetics [41]. As per the rules of 1945, rules 145 and 135 prohibit the use and import of lead and arsenic-containing compounds, and rules 135A and 145D prohibit mercury-containing cosmetics [142,143].

The import of certain cosmetics is regulated by the Indian Cosmetics and Drugs act of 1945. It is mentioned in section 10 of the Act and Rules 134A, 135A, and 135. These are,

- cosmetics that do not meet quality standards.
- misbranded and spurious cosmetic products
- the cosmetic that requires a specific license for importing or cosmetics that bought in compliance with such license.
- cosmetic that contains harmful substances that are unsafe to use.
- cosmetic products that are prohibited by rule for importing.
- cosmetic which contains hexachlorophene
- cosmetic products which contain lead and arsenic as a colouring agent.
- cosmetics with mercury content [144].

India also banned the testing of cosmetics on animals in 2014. The Health and Family Welfare Ministry has added a rule, according to this rule testing cosmetics on animals is prohibited, and using animals for testing cosmetic preparations should not be done by any manufacturers. India has also banned the import of such products that test on animals [145-147].

The European Union introduced a directive on regulating the monitoring of cosmetics in 1976 and this directive summarises that there should not be any damage or health hazard by the use of cosmetics at any conditions [148]. The USFDA has tested a variety of cosmetics on the market for heavy metals and they have set a safe limit for heavy metal content in cosmetics.

5. Conclusion and Future Perspectives

Regulation acts to prevent the rampant use of cosmetics but still, there are significant health and environmental risks from harmful heavy metals in chemicals present as ingredients. Many of these toxins have been linked to brain damage, reproductive hazards, and cancer-promoting effects by scientific research. The chemical ingredients used in cosmetics get flushed into our waste system which significantly affects the ecosystem as well. While these are there and guidelines from organizations like BIS, WHO, FDA to EU do exist stricter implementation is the need of the hour so that consumers' safety has been taken care of. The introduction of green cosmetics created under the guidelines set forth by Green Chemistry is an indisputable solution to counter these concerns. Environment-friendly and skin-safe cosmetics manufactured using naturally extracted organic compounds may prevent heavy metal toxicity, thereby, limiting its harmful consequences on human health as well as the environment. Yet, high production costs mean expensive paper fibers with time-consuming processes and slim profit margins.

Efforts in following up work should be on creating awareness among consumers, convincing manufacturers to switch over towards environment safe practices, and encouraging collaboration amongst government and industry bodies for promoting the growth of green cosmetics. Only by swapping out these contaminants for substitutes made from natural resources, and adopting eco-friendly practices can the cosmetic industry impact a better environment and clean consumer goods.

6. Conflict of Interest

The author declares no conflict of interest.

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